CLAIMS

1. A method of measurement of mitotic activity from histopathological specimen image data, characterised in that the method has the steps of:
   a) identifying pixels in the image data having luminances associated with mitotic figures;
   b) selecting from among the identified pixels a reference pixel which is sufficiently close in position and luminance to another identified pixel to provide a reference colour;
   c) locating pixels in the image data with luminances sufficiently close to that of the reference colour to indicate potentially mitotic figures;
   d) incrementing image regions corresponding to potentially mitotic figures from the located pixels by adding pixels thereto, potential increments to image regions being implemented or rejected by according to whether or not their luminances are sufficiently close to respective image region luminances and sufficiently far from an image data background luminance;
   e) selecting grown image regions on the basis of thresholds for image region area, compactness and width/height ratio; and
   f) counting selected grown image regions as actually indicating mitotic figures on the basis of a thresholds for number of such regions.

2. A method according to Claim 1 characterised in that the step of selecting grown image regions also involves thresholds for ratio of image region luminance to background luminance and area difference between areas derived by growing each image region with multiple thresholds.

3. A method according to Claim 2 characterised in that the thresholds for image region area, compactness, width/height ratio, luminance and area difference are: 355 pixels < area < 1700 pixels, 0.17 < compactness < 0.77, width/height ratio < 2.7, luminance percentage < 44%, area difference < 23area/100.

4. A method according to Claim 1 characterised in that the step of counting selected grown image regions as actually indicating mitotic figures also involves thresholds for region area and luminance.

5. A method according to Claim 1 characterised in that successive potential increments to image regions are individual pixels each of which is an immediate row or column neighbour of an existing image region pixel.

6. A method according to Claim 1 characterised in that step b) is implemented with a reference pixel having a luminance differing by less than 8% compared to another identified pixel distant from it by not more than two percent of a smaller of two image dimensions.

7. A method according to Claim 1 characterised in that step a) includes white balancing and median filtering the image data prior to identifying pixels having luminances corresponding to mitotic figures.

8. A method according to Claim 1 characterised in that in step c) pixels are cued for acceptance or rejection as regards indicating mitotic figures by:
   a) thresholding colour image data to remove pixels lacking intensities associated with mitotic figure imagery,
   b) removal pixels not present in all colours, and
   c) thresholding image region areas to remove those too small and too large to be potential mitotic figures.

9. A method according to Claim 1 characterised in that in step c) pixels are cued for acceptance or rejection as regards indicating mitotic figures by:
   a) segmenting to identify pixels with intensities associated with mitotic figure imagery,
   b) thresholding image region areas to remove those too small and too large to be potential mitotic figures,
   c) cluster analysis to determine whether or not a pixel's image region is in a sufficiently large cluster, and
   d) necrotic and hairy edge filtering.

10. A method of measuring mitotic activity from histopathological specimen image data, characterised in that the method has the steps of:
   a) measuring an intensity profile of an image region corresponding to a potentially mitotic figure, and

b) counting the image region as indicating a mitotic figure if its profile has a value greater than a prearranged threshold at a position in the profile having intensity associated with mitotic figure imagery.

11. A method according to Claim 10 characterised in that it includes counting the image region as indicating a mitotic figure if its profile has a first value not greater than the prearranged threshold at a position in the profile having intensity associated with mitotic figure imagery, a second value greater than a prearranged second threshold, a third value greater than a prearranged third threshold, and a minimum value less than a prearranged fourth threshold.

12. A method according to Claim 11 characterised in that the first value is at one end of the profile, the first and second values adjoin one another in the profile and the third value does not adjoin the second value.

13. A method according to Claim 11 characterised in that the image data comprise a first Principal Component obtained by Principal Component Analysis (PCA) of coloured image data.

14. A method according to Claim 11 characterised in that step a) includes preprocessing image data by:

a) decomposing the image data into overlapping sub-images,
b) applying PCA to the sub-images to derive a first Principal Component image,
c) thresholding the first Principal Component image to produce a binary image of blobs and background
d) rejecting blobs adjacent to or intersecting sub-image boundaries,
e) filling holes in blobs,
f) rejecting blobs too small to correspond to potential mitotic figures, and
g) reassembling the sub-images into a single image for image region profile measurement as aforesaid in step a).

15. A method according to Claim 14 characterised in that after step g) pixels are cued for acceptance or rejection as regards indicating mitotic figures by:

a) thresholding colour image data to remove pixels lacking intensities

associated with mitotic figure imagery,

b) removal pixels not present in all colours, and

c) thresholding image region areas to remove those too small and too large to be potential mitotic figures.

16. A method according to Claim 14 characterised in that after step g) pixels are cued for acceptance or rejection as regards indicating mitotic figures by:

a) segmenting to identify pixels with intensities associated with mitotic figure imagery,

b) thresholding image region areas to remove those too small and too large to be potential mitotic figures,

c) cluster analysis to determine whether or not a pixel's image region is in a sufficiently large cluster, and

d) necrotic and hairy edge filtering.

17. Computer apparatus for measuring mitotic activity from histopathological specimen image data, characterised in that it is programmed to execute the steps of:

a) identifying pixels in the image data having luminances associated with mitotic figures;

b) selecting from among the identified pixels a reference pixel which is sufficiently close in position and luminance to another identified pixel to provide a reference colour;

c) locating pixels in the image data with luminances sufficiently close to that of the reference colour to indicate potentially mitotic figures;

d) incrementing image regions corresponding to potentially mitotic figures from the located pixels by adding pixels thereto, potential increments to image regions being implemented or rejected by according to whether or not their luminances are sufficiently close to respective image region luminances and sufficiently far from an image data background luminance;

e) selecting grown image regions on the basis of thresholds for image region area, compactness and width/height ratio; and

f) counting selected grown image regions as actually indicating mitotic figures on the basis of a thresholds for number of such regions.

18. Apparatus according to Claim 17 characterised in that it is programmed to execute

the step of selecting grown image regions by also using thresholds for ratio of image region luminance to background luminance and area difference between areas derived by growing each image region with multiple thresholds.

19. Apparatus according to Claim 18 characterised in that the thresholds for image region area, compactness, width/height ratio, luminance and area difference are: 355 pixels < area < 1700 pixels, 0.17 < compactness < 0.77, width/height ratio < 2.7, luminance percentage < 44%, area difference < 23area/100.

20. Apparatus according to Claim 17 characterised in that it is programmed to execute the step of counting selected grown image regions as actually indicating mitotic figures by also using thresholds for region area and luminance.

21. Apparatus according to Claim 17 characterised in that successive potential increments to image regions are individual pixels each of which is an immediate row or column neighbour of an existing image region pixel.

22. Apparatus according to Claim 17 characterised in that it is programmed to execute step b) with a reference pixel having a luminance differing by less than 8% compared to another identified pixel distant from it by not more than two percent of a smaller of two image dimensions.

23. Computer apparatus for measuring mitotic activity from histopathological specimen image data, characterised in that it is programmed to execute the steps of:

a) measuring an intensity profile of an image region corresponding to a potentially mitotic figure, and

b) counting the image region as indicating a mitotic figure if its profile has a value greater than a prearranged threshold at a position in the profile having intensity associated with mitotic figure imagery.

24. Apparatus according to Claim 23 characterised in that it is also programmed to count an image region as indicating a mitotic figure if its profile has a first value not greater than the prearranged threshold at a position in the profile having intensity associated with mitotic figure imagery, a second value greater than a prearranged second threshold, a third value greater than a prearranged third threshold, and a

minimum value less than a prearranged fourth threshold.

25. Apparatus according to Claim 24 characterised in that the first value is at one end of the profile, the first and second values adjoin one another in the profile and the third value does not adjoin the second value.

26. Apparatus according to Claim 24 characterised in that the image data comprise a first Principal Component obtained by Principal Component Analysis (PCA) of coloured image data.

27. A computer program for use in measuring mitotic activity from histopathological specimen image data, characterised in that the computer program contains instructions to control a computer to implement the steps of:

a) identifying pixels in the image data having luminances associated with mitotic figures;

b) selecting from among the identified pixels a reference pixel which is sufficiently close in position and luminance to another identified pixel to provide a reference colour;

c) locating pixels in the image data with luminances sufficiently close to that of the reference colour to indicate potentially mitotic figures;

d) incrementing image regions corresponding to potentially mitotic figures from the located pixels by adding pixels thereto, potential increments to image regions being implemented or rejected by according to whether or not their luminances are sufficiently close to respective image region luminances and sufficiently far from an image data background luminance;

e) selecting grown image regions on the basis of thresholds for image region area, compactness and width/height ratio; and

f) counting selected grown image regions as actually indicating mitotic figures on the basis of a thresholds for number of such regions.

28. A computer program according to Claim 27 characterised in that its instructions provide for implementing the step of selecting grown image regions by also using thresholds for ratio of image region luminance to background luminance and area difference between areas derived by growing each image region with multiple thresholds.

29. A computer program according to Claim 28 characterised in that the thresholds for image region area, compactness, width/height ratio, luminance and area difference are: 355 pixels < area < 1700 pixels, 0.17 < compactness < 0.77, width/height ratio < 2.7, luminance percentage < 44%, area difference < 23area/100.

30. A computer program according to Claim 27characterised in that its instructions provide for implementing the step of counting selected grown image regions as actually indicating mitotic figures using also thresholds for region area and luminance.

31. A computer program for use in measuring mitotic activity from histopathological specimen image data, characterised in that that its instructions provide for implementing the steps of:

a) measuring an intensity profile of an image region corresponding to a potentially mitotic figure, and

b) counting the image region as indicating a mitotic figure if its profile has a value greater than a prearranged threshold at a position in the profile having intensity associated with mitotic figure imagery.

32. A computer program according to Claim 31characterised in that its instructions provide for counting the image region as indicating a mitotic figure if its profile has a first value not greater than the prearranged threshold at a position in the profile having intensity associated with mitotic figure imagery, a second value greater than a prearranged second threshold, a third value greater than a prearranged third threshold, and a minimum value less than a prearranged fourth threshold.

33. A computer program according to Claim 32 characterised in that the first value is at one end of the profile, the first and second values adjoin one another in the profile and the third value does not adjoin the second value.

34. A computer program according to Claim 32 characterised in that its instructions provide for step a) to include preprocessing image data by:

a) decomposing the image data into overlapping sub-images,

b) applying PCA to the sub-images to derive a first Principal Component image,

c) thresholding the first Principal Component image to produce a binary image of blobs and background

d) rejecting blobs adjacent to or intersecting sub-image boundaries,

e) filling holes in blobs,

f) rejecting blobs too small to correspond to potential mitotic figures, and

g) reassembling the sub-images into a single image for image region profile measurement as aforesaid in step a).